Analysis of Calcite Deposition and Infiltration-Percolation flux in Unsaturated Fractured Tuffs

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RESEARCH OBJECTIVES

The percolation flux in the unsaturated zone is an important parameter that must be addressed in site characterization and hydrological modeling of the potential Yucca Mountain, Nevada, nuclear waste repository. Hydrogenic calcite deposits found in fractures and lithophysal cavities at Yucca Mountain have been used to estimate past percolation fluxes. Calcite precipitation in the unsaturated fractured tuff may be affected by many factors, including infiltration-percolation rate, water and gas chemistry, effective kinetic reaction rate and mineralogy. This process occurs through a complex interplay of fluid flow, chemical transport and reaction processes.

APPROACH

Calcite deposition was analyzed using reactive transport modeling. The code TOUGHREACT (Xu and Pruess, 1998) which was used for the calcite analysis, considers the following essential processes: (1) fracture-matrix interaction for water flow and chemical constituents; (2) gaseous CO_2 diffusive transport and partitioning in liquid and gas phases; and (3) kinetics of fluid-rock chemical reactions. The ambient geothermal gradient is considered for geochemistry calculations. A number of simulations were performed using a range of variables that affect calcite precipitation.

RESULTS AND SIGNIFICANCE

Calcite abundances measured by the USGS (AMR U0085, 2000) were used as a basis for comparison and calibration to model results. Calcite distribution observed in borehole WT-24 were reasonably reproduced using a range of 2-20 mm/yr infiltration rate and modified reactive surface areas. This range of infiltration rate at this location is consistent with that calculated by USGS from infiltration modeling. The model presented is being used to further investigate processes for seepage in cavities that have been used as an analog for seepage into the potential repository waste emplacement drifts.

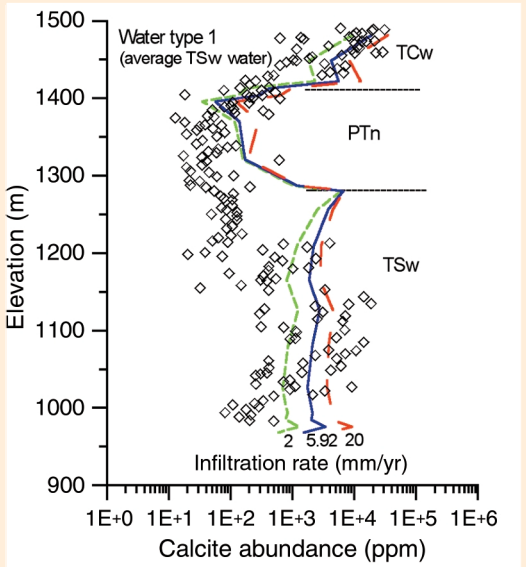

Figure 1. Simulated changes of calcite volume fraction (in ppmV, lines) after 10 million years in the WT-24 column together with measured mass abundances (in diamond symbols) that are taken from the report Analysis of Geochemical Data (USGS data reported in AMR U0085, 2000).

RELATED PUBLICATIONS

Fabryka-Martin, J., A. Meijer, B. Marshall, L. Neymark, J. Paces, J. Whelan, and A. Yang, Analysis of geochemical data for the Unsaturated Zone, ANL-NBS-HS-000017 Rev00., Las Vegas, Nev., CRWMS M&O, 2000.

Wu, Y.-S., J. Liu, T. Xu, C. Haukwa, W. Zhang, H.H. Liu, and C.F. Ahlers, UZ Flow models and submodels, MDL-NBS-HS-000006 Rev00., Las Vegas, Nev., CRWMS M&O, 2000.

Xu, T., and K. Pruess, Coupled modeling of non-isothermal multi-phase flow, solute transport and reactive chemistry in porous and fractured media: 1. Model Development and Validation, LBNL-42050, 1998.

ACKNOWLEDGEMENTS

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